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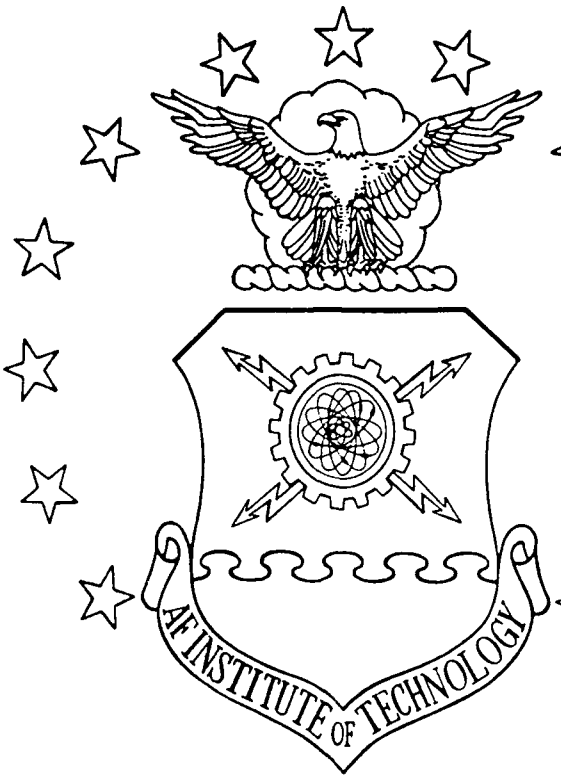

HOW MANAGEMENT INFORMATION SYSTEMS CAN ENHANCE THE AIR FORCE DRUG TESTING PROGRAM

THESIS

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THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

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Master of Science in Information Resource Management

Ramona L. Houchin, B.S.

Captain, USAF

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Ramona L. Houchin

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Abstract

This study examined the possibility that MIS can be applied towards the current Air Force drug testing program and result in an improved program. Current literature, including AF regulations and DOD directives, and information obtained from informal interviews conducted at the AFDTL were reviewed and analyzed. The findings indicated that there are areas in the drug testing program and the AFDTL itself that can be enhanced by the application of MIS concepts.

These areas include the manual processes performed throughout the drug testing sequence; information processing under the control of the Forensic Documentation Branch; the information maintained in the AFDTL database; and the transfer and maintenance of information relating to the drug testing program for AF bases serviced by the AFDTL.

Suggestions from this author regarding the application of MIS to these specific areas were presented in Chapter V. Current literature was also cited in Chapter V to substantiate these suggestions.

Since it was beyond the scope of this study to deter-mine if the suggestions can be feasibly incorporated intothe drug testing program, recommendations for further study were presented. Future study (or studies) should be geared specifically to the integration of robotics, bar coding, and additional automation into the drug testing program.

HOW MANAGEMENT INFORMATION SYSTEMS CAN ENHANCE THE AIR FORCE DRUG TESTING PROGRAM

I. Introduction

Background

Information is a valuable asset. According to Leslie S. Chalmers, a noted researcher, "accurate and timely information is the lifeblood of many companies" (10:37) and of many military organizations.

The value of information to a military organization " ... depends on its context, the effort required to collect it, and the risk incurred if the information is disclosed, lost or modified" (10:38). Due to the severe penalties to military personnel for drug use and the impact on military readiness due to drug use, the value of information related to the military drug testing program, including the drug testing processes and results, is especially high.

Commanders must place emphasis on the recognition of valuable information; failure to do so could have " ... social, legal, and moral ramifications" (10:37) that

could adversely affect the readiness of America's armed forces. As the Air Force, a vital part of America's armed forces, enters the 21st century, information, such as drug testing, is increasingly being managed by Management Information Systems (MIS). The combination of harsh penalties for drug use, the unreliability of certain drug tests, the standardization of valuable information management, and the development of an MIS present commanders with a unique opportunity to enhance military discipline, raise morale, and increase the quality of military manpower.

This unique opportunity involves the combination of drug testing and an MIS to improve the quality of the military forces. The concepts of drug testing and MIS are based upon a solid foundation of published articles and regulations. Because both drug testing and information management are so strongly related to overall military force quality, this thesis will suggest several approaches to the management of information as it relates to the Air Force drug testing program based upon informal interviews and published articles in the two apparently unrelated areas of drug testing and MIS concepts.

The general issue is presented next, followed by the problem statement, a brief review of the literature, the

scope of the study, and investigative questions. The chapter is concluded with the expected benefits of this study.

General Issue

According to Air Force Regulations (AFR) 30-2, Social Actions Program (19), and 160-23, Drug Abuse Testing Program (18), drug testing in the Air Force implies a given logic and philosophy exist behind the military drug testing program. While the military's purposes for testing for drug abuse differ from the civilian sector's purposes, one similarity is the high cost of testing both military and civilian employees, from $35 to $100 per urine sample (44:16) for the entire testing process.

During the same time the military drug testing program was being developed, the Air Force was becoming aware of MIS, computer-based information systems to support organizational processes. As the Air Force prepares for the 21st century, it is attempting to integrate MIS to improve overall efficiency and quality. Therefore, it is possible that MIS concepts may be used to enhance the military drug testing program and overall force quality.

Problem Statement

Since no one has investigated the possibility that MIS concepts may be applied towards the current Air Force drug testing program, this researcher will explore these two unrelated fields to determine if MIS concepts could be used to enhance the Air Force drug testing program.

Review of the Literature on the General Issue

This section provides information on drug testing in the workplace and MIS concepts. The literature on drug testing will be presented first, followed by the MIS literature review.

Drug Testing Literature. Drug testing refers specifically to the urine screening test and the blood sample test used to detect controlled substances such as marijuana, cocaine, amphetamines, opiates, and phenyclidine (PCP) (3; 7; 15; 18; 29; 31; 37; 43; 44). Intoxication is defined, for the purpose of this thesis, as impairment while under the influence of drugs.

The military began the first federal drug testing program in 1971 because of " ... reports of epidemic drug use among GIs in Vietnam ... " (44:15). Today, the military is " ... the largest user of drug tests ... " (31:35) with drug

rehabilitation centers and prisons being the next largest users. The military and prisons test for drugs because of the illegality of drug abuse. (31:35)

Numerous law cases demonstrate that the military's security issues provide for a relaxation of Fourth Amendment rights in the interest of society. The greater the risk to society of the effect of an individual using drugs, the less suspicion is needed for the military to test for drugs (41; 51; 52; 62; 63). In the civilian sector, the same legal theory applies, which is why it is more difficult for a civilian employer to justify drug testing in some areas of employment. However, the courts do allow drug testing in civilian jobs in cases in which the benefit to, or safety of, society is clearly demonstrated.

In 1981, drug testing, specifically urine testing for marijuana, was introduced to the private sector (31:34). Since then, programs to test employees in both the public and private sector have been instituted (37:238). Between 1984 and 1988, the percentage of Fortune 500 companies conducting testing increased from 5 to 30 percent with more than 20 percent planning to implement some kind of drug testing in the near future (29:74; 44:41). Today, approximately one-third of the country's businesses and government

agencies test for drugs with the majority of these being companies/agencies that directly serve the public (29:74).

Most public and private sector companies/agencies are testing for drugs as pre-employment screening; for reasonable cause; and as a concern for public safety (3; 7; 15; 18; 19; 29; 31; 37; 43; 44; 50).

The urinalysis test most often used is the enzyme multiplied immunoassay test (EMIT), and it is also the test cited to have the greatest accuracy problems (1:54-55; 3:613; 13:216; 31:35; 54:53). There are alternate methods for drug testing, one proven to be more accurate than the EMIT and two that are claimed to "measure marijuana intoxication" (31:37). Only the gas chromatography/mass spectrometry (GC/MS) urinalysis test has been implemented (3:614; 31:37; 44:16).

> A 1987 NIDA report on the status of drug testing litigation said that the gas-chromatograph "has been conceded by the National Treasury Employees Union, federal judges and technical experts alike to be 100 percent accurate." (44:16)

The alternate methods claimed to "measure marijuana intoxication" (31:37) are the saliva test and the brain scan test "called ADMIT (alcohol drug motorsensory impairment test)" (31:37). The saliva test tests a person's saliva for

> delta-9 THC, the psychoactive ingredient in marijuana and other drugs such as amphetamines, barbituates, cocaine, methaqualone, morphine, and phenyclidine. (31:37)

> The manufacturer of the brain scan test ... claims that it can measure drug and alcohol impairment by reading a person's brain waves electronically. The results are obtained in one minute and can detect alcohol, hallucinogens, tranquilizers, barbituates, opiates, marijuana, cocaines, and amphetamines. (31:37)

MIS Literature. MIS will refer to

> an integrated user-machine system for providing information to support operations, management, analysis and decision making functions in an organization. The system utilizes computer hardware and software; manual procedures; models for analysis, planning, control and decision making; and a database. (14:6)

The MIS concept is an association of related subsystems that serve managerial needs in various ways. The subsystems, which may include data processing, decision support systems, information resource management, and end-user computing, are developed and implemented as needed, but they still conform to the overall plan and procedures for the actual MIS. The subsystems are integrated through the use of the MIS database. This concept is designed to reduce the costs of obtaining, processing, and storing information, and to increase the information processing capabilities. (14:10,22; 23:1631; 38; 49:22)

For the MIS concept to work, comprehensive planning for the design of the actual information system must be accomplished (4; 5; 14:444-468; 23; 34; 40; 56). This comprehensive planning includes three basic stages:

1. Strategic planning, which establishes a relationship between the MIS plan and the overall organization plan;

2. Organizational information requirements and analysis, which identify organizational information requirements to establish a strategic information architecture to be used to direct specific application development projects; and

3. Resource allocation, which is the allocation of both MIS application development resources and organizational resources. (4:13-14; 5:17; 14:455-456; 38; 39:287-288; 49; 56)

Involvement of top management and system users during the design planning stage indicates a greater likelihood of success for the information system (2:25; 20:732; 34; 39:287; 40:446-447). In essence, the more involved top management and the system users are in the design planning, the more likely they are to accept and use the system. Use of the system is one measure of the success of the MIS

(20:178; 23:1631). A large usage volume indicates increased user satisfaction and the potential for a successful MIS.

In most MIS, information is a valuable resource that requires protection from destruction or misuse (10; 14:670; 46:397-401). Processes may be implemented to protect information and to ensure only authorized personnel can gain access to protected information. Such processes include encryption, passwords, and biometric devices (46:400-401).

"Encryption is the coding (or scrambling) of data so they cannot be read by humans" (46:400). If encryption is used, authorized personnel are provided "routines for decoding the data" (46:401).

Passwords are secret words, intended to be known only by authorized users of the system, that allow users to gain access to a computer or its resources (46:401). The problem with passwords is "they give no indication of who is trying to gain access" (46:401) to the system. If the password is correct, the user, authorized or not, can access the information system.

Biometric devices "measure or detect personal characteristics such as fingerprints, voice prints, retina prints, or signature dynamics" (46:401). Although not fully

developed, these devices appear to be the most promising processes to positively identify potential system users (46:401).

Scope

This study will cover issues concerning the Air Force drug testing program and MIS concepts, and make recommendations for applying MIS to the program. The drug testing issues to be researched concern the accuracy (or inaccuracy) of drug testing procedures used by the Air Force and the efficiency of the overall program. The areas dealing with MIS to be researched are the MIS concept; MIS planning; and MIS security.

Limitations of the Research. The researcher will draw upon the literature and informal interviews to correlate drug testing and MIS concepts, and to analyze this relationship. Neither a computer program nor a MIS will be developed from this study.

Investigative Questions

The following investigative questions will guide the research, and when these questions are answered, the specific problem will be solved.

1. What is the accuracy of the drug tests used in the Air Force Drug Testing Laboratory?

2. How can an MIS enhance the current Air Force drug testing program?

3. How can the information derived from the drug testing program be more tightly secured or protected from unauthorized access?

Expected Benefits of the Study

An MIS ia a system to improve the management of information. At its heart, the Air Force drug testing program is an information system. All information systems have basically the same structure and goal of satisfying organizational needs. Theoretically, MIS concepts can be applied to information and improvement will result. Therefore, applying MIS concepts to the current Air Force drug testing program is expected to result in overall improvement in the areas of efficiency and quality.

In order to give the reader more insight into the the Air Force drug testing program and the MIS field, a review of published information and informal interviews is presented in Chapter II of this thesis. This will provide information to answer the investigative questions. The

findings will be presented in Chapter IV. Conclusions will be drawn and recommendations for further study will be presented in Chapter V.

II. Review of the Literature

Introduction

This chapter presents specific information about the current Air Force drug testing program and general information about MIS. The information obtained from the literature about the Air Force drug testing program will be presented first, and a review of MIS literature will follow.

Review of Drug Testing Program Literature

Many articles have been written and published in recent years about drug testing programs in the workplace. Some of these articles have criticized the overall concept of drug testing programs, and others have revealed elements that must be present for a drug testing program to be operated within legal limits.

The elements identified in various articles as being necessary in a drug testing program are as follows:

1. a well known and written drug abuse and testing policy that defines the drug testing program's aims (7:191; 26:16; 27:121; 37:745; 43:44; 54:53);

2. testing methods that include a good screening technique and a more accurate technique for confirmation testing (1:58-59; 7:192; 26:17; 27:123; 28:79; 29:75; 31:37; 33:155; 34:745; 64:72);

3. a reputable laboratory to conduct the testing (54:53; 64:72);

4. a strict chain of custody procedure which will track the specimen through the entire drug testing sequence (27:123; 29:75; 31:38; 33:153; 43:45; 64:72);

5. confidentiality of test results (7:191; 27:124; 33:155; 43:45; 64:72); and

6. a drug rehabilitation or assistance program for employees involved in drug abuse (26:17; 27:124; 29:75; 33:155; 43:45; 54:54-55; 64:72).

From the literature reviewed, there is evidence to support that the Air Force has integrated all of these elements into its drug testing program. The evidence is published in Department of Defense Directive (DODD) 1010.1 (17), AFR 160-23 (18), and AFR 30-2 (19), and it will be visible throughout this section.

Written Policy. The Air Force has a written policy regarding drug abuse and drug testing, and the policy is set forth in AFR 160-23 (18) and AFR 30-2 (19). Both of these

regulations support the DOD's policy concerning the military services' drug testing programs.

The DOD's policy is that the drug testing program implemented by each service be used to:

> 1. Preserve the health of members of the Military Services by identifying drug abusers in order to provide appropriate counseling, rehabilitation, or other medical treatment. (17:1)
>
> 2. Permit commanders to assess the security, military fitness, and good order and discipline of their commands, and to take appropriate action based upon such an assessment. (17:1)

The Air Force's general policy regarding drug abuse is

> All personnel are expected to refrain from substance abuse and maintain Air Force standards of behavior, performance, and discipline consistent with the UCMJ, public law, and Air Force publications. (19:10)

To support both of these policies, the Air Force has developed and implemented a program with several goals. The first and most important goal is to discourage drug abuse among Air Force members and their family members (18:1; 19:10). Other goals of the program include identifying Air Force members involved in drug abuse who require treatment and/or rehabilitation programs (18:1); gathering enough evidence against an abuser to support administrative actions under the UCMJ (18:1; 19:26); collecting data to determine how widespread drug abuse is in the Air Force (18:1); and,

through the program, helping commanders " ... maintain the morale, welfare, and health of their commands" (18:1).

Just because the policy is written doesn't mean the policy is well known. However, the Air Force ensures its drug abuse and testing policy is common knowledge by briefing the policy to cadets and applicants prior to enlistment and by briefing active duty members every time they have a permanent change of station.

The above-mentioned regulations and briefings constitute a well known and written drug abuse and testing policy. Therefore, the Air Force's program contains the first necessary element for a legally operated drug testing program.

Testing Methods. For a drug testing program to be considered within legal limits, it must employ two testing methods, one for screening and one for the confirmation testing of positive urine samples identified by the screening test (19; 27:123; 28:79; 29:75; 31:37; 33:156; 37:745). The most common screening tests used are in the form of an immunoassay, such as the EMIT and the radioimmunoassay (RIA) (26:17; 27:123; 28:79).

> An immunoassay is an analysis of a body fluid for the purpose of detecting the presence of a drug or drug metabolite. It is based on the principle of competition between labeled and unlabeled antigens for binding sites on a specific antibody. (An antibody is a protein substance to which a specific drug or drug metabolite will bind.) (28:80)

The best and most commonly used confirmation test to date is the GC/MS (26:17; 27:123; 28:80; 31:37), " ... an assay procedure which analyzes the unique ion fragmentation ("fingerprint") of drugs" (19:25).

Because the Air Force uses the RIA for screening and the GC/MS for confirmation testing (17:3-2; 18:4; 19:25), these methods will be described in detail.

RIA. The RIA screening technique involves the addition of a "radioactive-labeled drug" (28:80), the antigen, and antibody reagents to a urine sample (19:25; 28:80). After the antigen and reagents have been added, the urine sample is set aside and left alone so that the antigen and the drug being tested for can compete for binding sites on the antibody reagents (19:25; 28:80).

"The resulting mixture is centrifuged to separate the antigen and antibody complexes, ... " (19:25). When the centrifugation has been completed, the mixture is placed in a gamma radiation counter to determine the radioactivity level of the sample (19:25; 28:80). "The level of radio-

activity is proportional to the amount of specific drug in the urine" (19:25), and the amount of drug present in the urine is measured in nanograms (19:25; 28:80).

The RIA is sensitive enough that it can detect very small amounts of drugs, one to five nanograms, in a milliliter of urine (19:25; 28:80). Because of the RIA's sensitivity, the AFDTL uses a minimum drug concentration level, established by the Assistant Secretary of Defense (Human Affairs) (ASD(HA)) (18:3-2), much higher than the RIA's sensitivity level for identifying positive urine samples (19:25).

When a urine sample produces a negative test result after the administration of the RIA at the AFDTL, the sample is discarded and reported as negative (18:3-3). If the urine sample tests positive, it is submitted for confirmation testing by the GC/MS (17:3-2; 18:4; 19:25).

GC/MS. The GC/MS is the incorporation of the gas chromatograph (GC) and the mass spectrometry (MS) techniques into an instrument that can detect the presence of a drug and identify the type of that particular drug (19:25; 28:81; 35). For instance, if the GC/MS detects narcotics (opiates or cocaine) in the urine sample, it can also determine the

exact type of narcotic, such as heroin, crack, or morphine (19:11).

The AFDTL uses GC/MS equipment produced by Hewlett-Packard, and this equipment is pictured in Figure 1. Hewlett-Packard's definition of the GC/MS is presented in Figure 2 while an explanation of how the GC/MS works follows in Figure 3. Figure 4 identifies mass spectra and defines the " ... unique ion fragmentation ("fingerprint") of drugs" (19:25).

In layman's terms, the GC portion of the GC/MS breaks down drugs into their purest form. The GC procedure, which can be followed by viewing Figure 5, the left side of Hewlett-Packard's GC/MS equipment, involves the injection of drug extracts taken from a urine sample into the GC/MS equipment through the injection port (28:81; 35; 42). From the injection port, the extracts move through the GC column a gas at different speeds, and when the extracts reach the interface between the GC and MS, the drugs are separated from one another and are broken down into their purest form (28:81; 35; 42).

The MS portion of the GC/MS can be better understood by referencing Figure 6, the right side of the GC/MS hardware. The MS breaks the drugs down further into molecules, and the

The GC/MS System Hardware

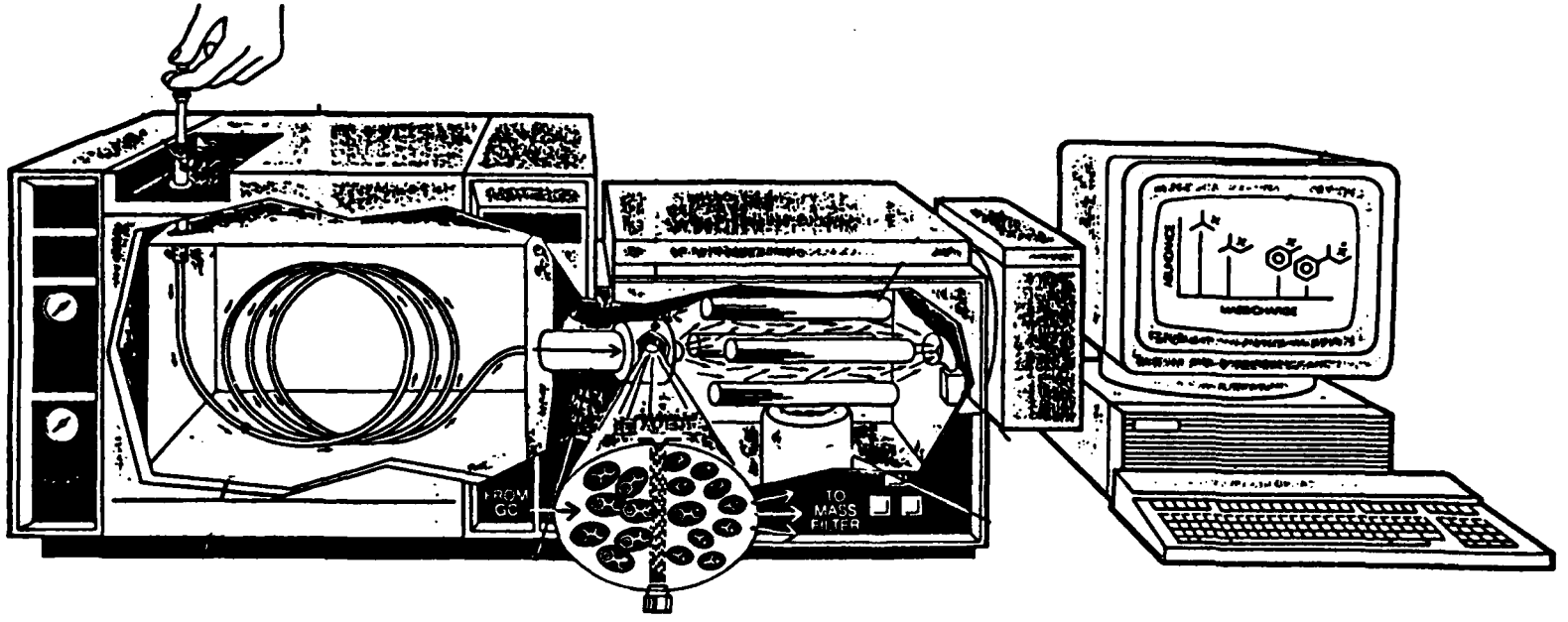


Figure 1. Hewlett-Packard's GC/MS System Hardware

What is GC/MS?

The combination of two powerful analytical techniques.

SEPARATION

Gas chromatography is the physical separation of two or more compounds based on their differential distribution between two phases. The gas chromatograph employs a carrier gas (mobile phase) to move a vaporized sample through a column coated with a stationary phase where separation takes place. A detector converts the column eluent to an electrical signal that is measured and recorded.

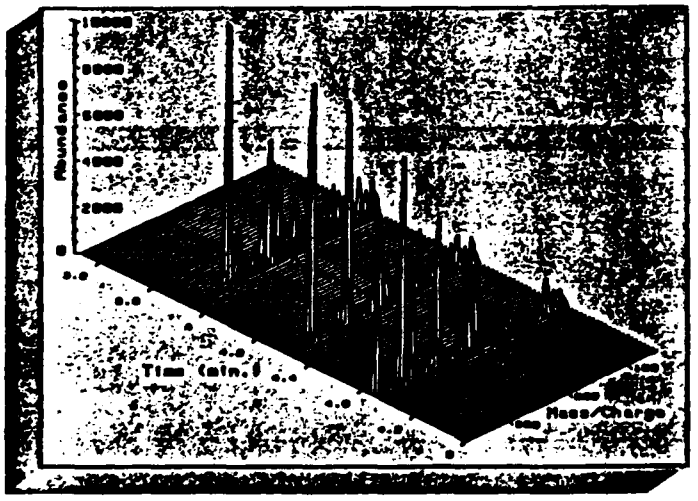
The output of the GC is a plot of detector signal abundance versus time. The abundance remains at a low "baseline" level except when a separated sample component elutes from the column and produces a peak in the chromatogram plot.

Chromatographic peaks can be identified from their corresponding RETENTION TIMES, measured from the time of sample injection to the time of the peak maximum. The retention time of any component peak is unaffected by the presence of other sample components. The height or area of a peak may be used to measure the concentration of a component in the sample mixture.

MASS ANALYSIS

A mass spectrometer is one kind of GC detector. As the separated sample component molecules elute from the column to the inside of the MS they are bombarded with energy. This causes them to lose an electron and form ions with a positive charge. Some of the bonds holding the molecule together are broken in the process, and the resulting fragments may rearrange or break up further to form more stable fragments. Because of natural laws governing the relative strengths of chemical bonds, a given compound will ionize, fragment, and rearrange reproducibly under a given set of conditions.

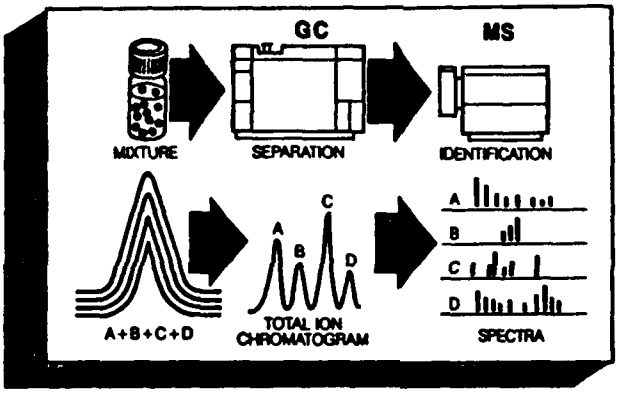
A mass spectrum is a recording of the masses of each of the ionized fragments, representing a unique fingerprint of a molecule that can be used in identification.



Gas chromatographic data is two-dimensional, i.e., a plot of signal abundance versus time. A mass spectrometer adds another dimension to GC data, i.e., abundance AND MASS versus time. The GC/MS chromatogram represents the sum of all ions detected, or TOTAL ION CHROMATOGRAM.

Figure 2. Hewlett-Packard's Definition of GC/MS (35)

How GC/MS works



As shown above, the sample is separated into its components by the gas chromatograph. The components are then ionized and identified by their characteristic spectra produced by the mass spectrometer.

LIKE SOLVING A PUZZLE ...

Molecular fragments appear in a mass spectrum and provide clues to the identity and molecular structure of the parent molecule similar to the way pieces of a jigsaw puzzle provide clues to the structure of the intact puzzle.

Below we see the mass spectrum of chloroform, $CHCl_3$. The molecular weight of chloroform is 118 daltons, and we can see a small cluster of ions around mass 118. The most abundant ion in the spectrum is at 83 daltons. The mass peak at 83 daltons is obtained through a loss of one Cl ion (one isotope of Cl has a nominal ion mass of 35, and 118 daltons − 35 daltons = 83 daltons). The loss of another Cl from the fragment at mass 83 yields the peak at mass 48. The ions at masses 50, 85 and 120 are due to the contribution of ^{37}Cl which has an abundance in nature of 24.23% relative to ^{35}Cl at 75.77%.

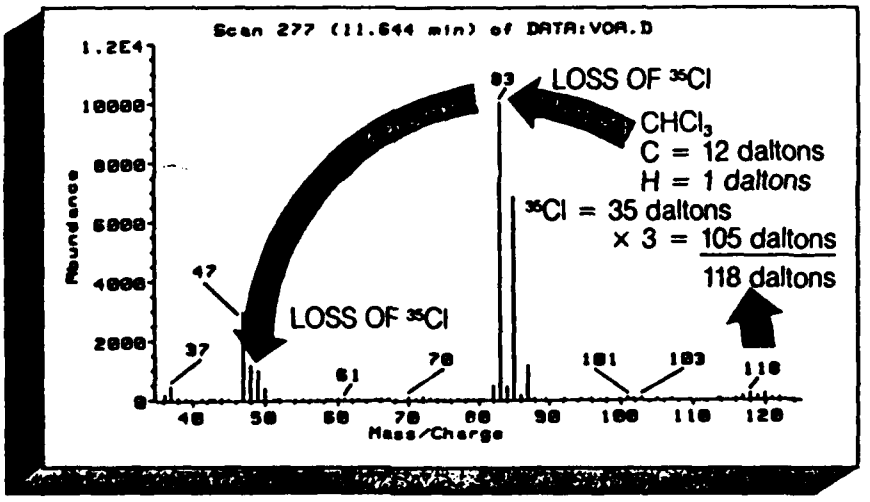


Figure 3. How the GC/MS Works (35)

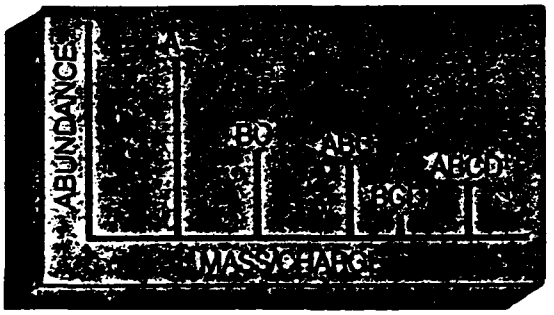
What are Mass Spectra?

"MOLECULAR FINGERPRINTS"

A mass spectrum is a plot showing the mass/charge ratio (in daltons or atomic mass units) versus abundance data for ions from the sample molecule and its fragments. Most ions formed by GC/MS have a charge of +1. The mass/charge ratio of any fragment is therefore normally equal to the mass for that fragment. The largest peak in the spectrum is called the BASE PEAK.

Certain fragments are more prone to form from the parent molecule than others, due to the presence of functional groups in the molecule and their interconnection. The masses of these fragments are used to deduce the structure of the parent compound.

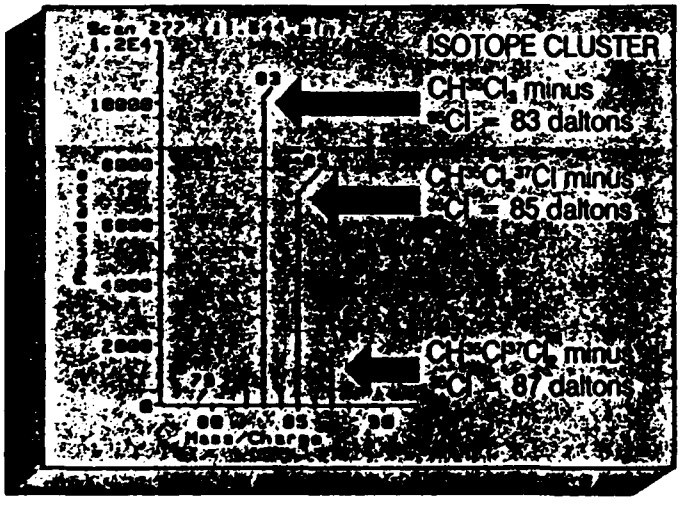
The ionized parent molecule, when seen as part of the mass spectrum, is referred to as the MOLECULAR ION. Occasionally the molecule is so totally fragmented by the ionizing process that little or no molecular ion is seen.



Ionization: **Fragmentation:**

$$ABCD \xrightarrow{-e} ABCD^{\cdot} \rightarrow A^{+} + BCD\cdot$$
$$\text{neutral molecule} \qquad \text{molecular ion} \rightarrow A\cdot + BCD^{+}$$
$$\hookrightarrow BC^{+} + D$$
$$\rightarrow D\cdot + ABC^{+}$$
$$\hookrightarrow A + BC^{+}$$

The mass spectra of certain compounds exhibit clusters of mass peaks. These clusters represent "naturally occurring impurities," or isotopes, that are present for carbon, nitrogen, sulfur, chlorine, bromine, and a few other elements. The relative percentages of these cluster ions provide more clues useful in unraveling the identity of a parent molecule from its molecular fingerprint.



Element	Symbol	Natural Abundance
Carbon	^{12}C	98.9 %
	^{13}C	1.1 %
Nitrogen	^{14}N	99.6 %
	^{15}N	0.4 %
Sulfur	^{32}S	95.02%
	^{33}S	0.76%
	^{34}S	4.22%
Chlorine	^{35}Cl	75.77%
	^{37}Cl	24.23%
Bromine	^{79}Br	50.5 %
	^{81}Br	49.5 %

Figure 4. Definition of Mass Spectra (35)

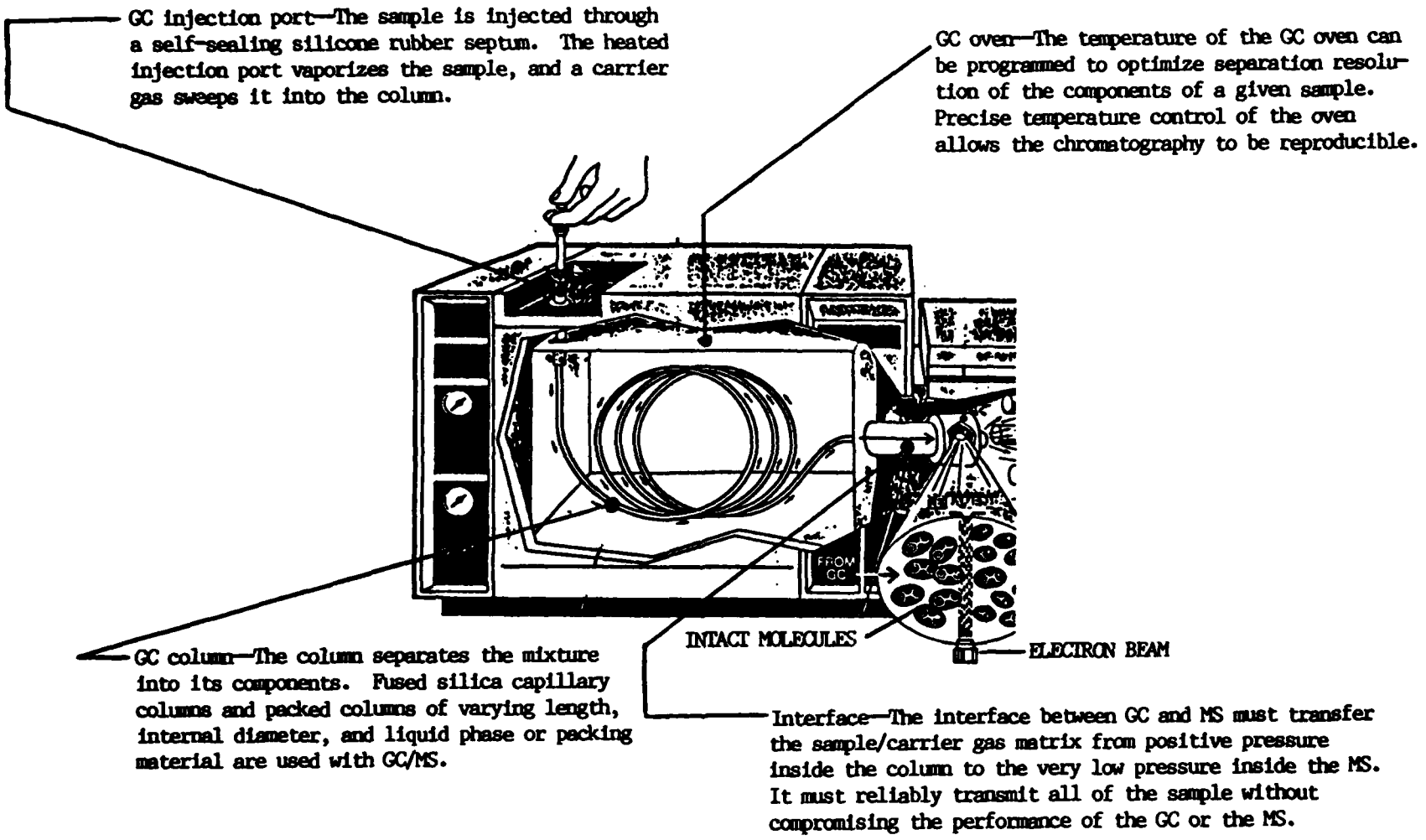


Figure 5. View of the Left Side of the GC/MS Hardware (35)

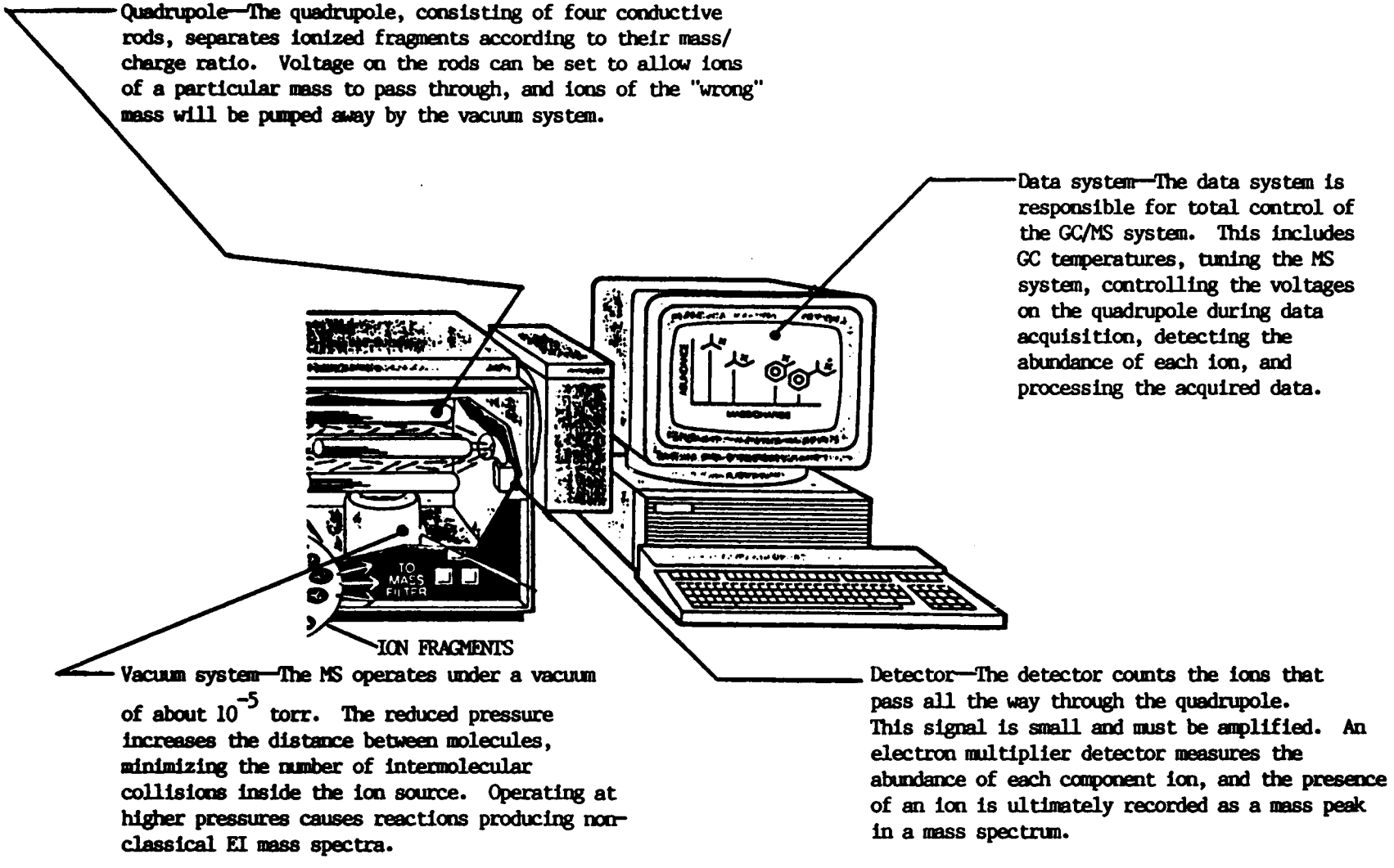


Figure 6. View of the Right Side of the GC/MS Hardware (35)

quadrupole measures each one to ensure that only molecules of a certain weight proceed through the rest of the GC/MS (28:81; 35; 42). The detector then analyzes the molecules to determine if their structure matches the already known structure ("fingerprint") of the drug being tested for as recorded in the memory of the data system (28:81; 35; 42). Since the AFDTL uses the RIA, a fairly sensitive and accurate screening method, and the GC/MS, " ... the most reliable ... " (3:614) urine test available today, the Air Force's drug testing program includes testing methods that federal courts have determined to be legally sufficient in proving drug use (52). Thus, the Air Force's program has the second element of a legally designed drug testing program.

Reputable Drug Testing Laboratory. A reputable laboratory is not just a laboratory with a good reputation. A reputable laboratory, used in this context, is a laboratory that uses sound analytical screening and confirmation testing; maintains the chain of custody; and is certified by proper authorities as being proficient in drug analyses (26:17; 28:82; 33:156).

According to these requirements, the AFDTL is a reputable laboratory. It employs the RIA and GC/MS methods of

testing which have been proven to be analytically sound by federal courts. It maintains the chain of custody by documenting who had possession of a specific urine sample at what point in the testing sequence (17:2-1,3-1; 18:8-9). (Chain of custody will be discussed in detail as an element of a sound drug testing program.) The AFDTL is certified by the DOD, and it is subjected to numerous inspections in any given year (17:4-1,4-2; 18:4).

According to DODD 1010.1 (17), the AFDTL has to be certified " ... to ensure that results are legally supportable and scientifically accurate" (17:4-1). To obtain this certification, the AFDTL met the following requirements as set forth in DODD 1010.1.

1. Maintain a Standard Operating Procedure manual approved by the Department of the Air Force.

2. Maintain an intralaboratory chain of custody when testing specimens.

3. Document training and qualifications of all laboratory personnel.

4. Maintain calibration and maintenance records on all laboratory equipment and instruments.

5. Validate analytical methods used for each drug.

6. Maintain an internal quality control program.

7. Set procedures for timely and appropriate responses to inquiries. (17:4-1)

To ensure the AFDTL continuously satisfies these requirements, it is inspected by a quality assurance team from the Department of the Air Force at least four times a year. It is also inspected at least once a year by a quality assurance team from outside the Department of the Air Force. (17:4-1; 42)

For the AFDTL to retain its certification, it must also participate in a proficiency testing program that is approved by both the Armed Forces Institute of Pathology and the Deputy Assistant Secretary of Defense (Professional Affairs and Quality Assurance). This program's purpose is to evaluate the AFDTL's ability to conduct drug analyses correctly. (17:4-2)

The AFDTL uses one of the most accurate screening methods and the most accurate confirmation method in testing urine samples. It maintains a strict chain of custody, and it undergoes stringent inspections to retain its certification. The AFDTL has what it takes to be a reputable laboratory and because the Air Force uses this laboratory in its drug testing program, the Air Force has the third element of a good drug testing program.

Chain of Custody. The chain of custody procedures for the entire drug testing sequence, from collection of the urine sample to the disposal or retention of the sample after completion of testing at the AFDTL, are found in DODD 1010.1 (17) and AFR 160-23 (18).

The chain of custody begins with the collection of the urine sample from the Air Force member. When the member arrives at the place of testing, the testing monitor verifies his or her identity with a valid identification card. Only after this validation is the member given a specimen bottle. The specimen bottle has a label affixed with the following information:

1. The day, month, and year of the urine collection (18:5).

2. The base accession number (18:5).

3. The member's social security number (18:5).

After the member ensures the social security on the bottle label is correct, he or she then verifies information in a ledger maintained by the testing monitor. The ledger contains the same information as the bottle label plus the member's rank and full name. (18:5)

Following the verification exercise, the member is assigned an observer of the same sex (17:2-1; 18:5). An

observer is appointed to ensure that the specimen collected is actually from the member identified. If there is not direct supervision, there is a possibility that a person may either substitute another specimen for his or her own, or a person may add a substance that will confuse the drug analyses.

> Numerous substances, including salt, bleach, ammonia, perfume, and tap water, can be used as adulterants. The addition of these substances may frustrate the analytical process by diluting the specimen or interfering with the physiochemical basis of the analysis. (33:154)

After the urine is collected, the member pours the urine in the specimen bottle and caps it in front of the observer. The observer than applies tamper resistant tape from one side of the bottle over the lid to the other side of the bottle. The member initials the bottle to certify " ... the authenticity and purity of the specimen, the correctness of the SSN, and the witnessing of application of the tamper resistant tape" (18:5). The observer then initials the bottle to certify that he or she did in fact observe the member provide the sample. Both the member and observer then print and sign their names in the ledger next to the previously verified information of the member. (17:2-1,2-2; 18:5-6)

When all specimens have been collected for a particular base and placed in a box for shipment to the AFDTL, the testing monitor fills out an AF Form 1890, Urinalysis Custody and Record Report. The testing monitor also signs and dates the form to verify that chain of custody procedures have been followed. The box is then sealed with adhesive tape. The testing monitor signs across the adhesive tape placed on the top and bottom of the box, and then attaches an envelope to the box. After annotating the AF Form 1890 with a release statement, a statement to identify who the box was released to for shipment to the AFDTL, the form is placed in the envelope which remains unsealed. The box is then wrapped with mailing paper and marked on the outside with the words " ... "Chain of Custody" to alert the drug testing laboratory that chain of custody specimens are in the package" (18:8). The box is then shipped to the AFDTL by means previously approved by the ASD(HA) (17:2-2). These means include first class mail, registered mail, Military Airlift Command transportation, commercial air freight, air express, and carried by hand. (18:8)

Once the box arrives at the AFDTL, the person receiving the box inspects it to ensure that it has not been tampered with or opened. Once this inspection has been conducted,

the outer wrappings are removed, and the AF Form 1890 is located. The receiving person annotates the form with the date, his or her signature, and the condition of the box upon arrival. This person then inspects the specimen bottles to ensure that the tape is intact on all of the bottles. When this inspection has been satisfied, accession numbers are assigned to each specimen, and they are annotated on the AF Form 1890. (18:9)

From this point on, every time the urine samples change hands in the AFDTL, the AF Form 1890 is annotated by the person receiving the samples (42). The AFDTL and the drug testing program adhere strictly to chain of custody procedures and if there is any discrepancy in the chain that cannot be explained, the sample under question is not tested (18:8,9; 42).

DODD 1010.1 and AFR 160-23 provide stringent guidelines for chain of custody procedures that must be followed. Because these guidelines are followed in the execution of the Air Force drug testing program, the program has the fourth element identified at the beginning of the chapter.

Confidentiality of Test Results. AFR 30-2 (18) cites the statutes and regulations that govern the confidentiality of documents that contain any information concerning drug

use. These statutes include The Privacy Act of 1974, AFR 12-35, AFR 40-792, 42 U.S.C. 290dd-3 and 290ee-3 (19:16). Basically, these statutes state that any information concerning an Air Force member and his or her use of drugs can only be released " ... for purposes authorized by law and may not be introduced against the member in a court-martial" (19:16).

According to AFR 30-2 (19), documents that contain any information about military members and their use of drugs must be specially marked to show that they are protected by these statutes. These records must also be stored in lockable containers when not being used (19:16). If, for any reason, any of these documents must be geographically transferred, they must be transferred via certified mail (19:17).

There are some people within the DOD community that are authorized access to this kind of information, but their access is for official purposes only. No information can be released outside of the DOD unless it is authorized by the Privacy Act of 1974 (19:17).

The drug testing program implemented by the Air Force also contains the fifth element of a responsible drug testing program. This is evident by the Air Force's publication of regulations that set forth procedures for maintaining the

confidentiality of information pertaining to drug users and the results of drug tests.

Drug Rehabilitation or Assistance Program. The Air Force's drug testing program contains the sixth element required of a legally operated drug testing program by the mere existence of the Substance Abuse Reorientation and Treatment Program. The program offers a variety of services, such as " ... assistance/education/referral/treatment programs for members involved in substance abuse ... " (19:11). "The Air Force will provide treatment when indicated, try to restore to duty drug abusers identified for retention and assist those being discharged in their transition to civilian life" (19:10).

From the literature reviewed, it is apparent that the DOD and the Air Force have integrated the elements of a responsible, legal drug testing program into the Air Force's drug testing program. If all of the standards set forth in the Air Force's drug testing program are maintained and followed, the potential for legal challenge is erased.

Review of MIS Literature

Since the late 1960s, when the concept of MIS first began to develop (21:4), many articles have been written and

published about MIS. The exact number of articles is not important. What is important is that nearly every article written presents a different definition of MIS. There is no consensus among all of the authors as to what MIS is.

As stated in Chapter I, for the purpose of this thesis, MIS will be defined as Davis and Olson (14) defined it in Management Information Systems: Conceptual Foundations, Structure, and Development. MIS will refer to

> an integrated user-machine system for providing information to support operations, management, analysis and decision making functions in an organization. The system utilizes computer hardware and software; manual procedures; models for analysis, planning, control and decision making; and a database. (14:6)

Since the database is what integrates the subsystems (data processing, decision support systems, information resource management, and end-user computing) of the MIS (14:10; 23:1631; 30; 49:22), it is the heart of the MIS, and it is discussed briefly.

A database is a collection of information, shared by users in the organization, that has been entered into the organization's central or main computer (9:66; 46:3). The database is made operational through a database management system (DBMS). A DBMS is software (9:66; 14:502; 36:80; 46:24) that performs several functions for the user and for

the MIS as a whole. For the user, the DBMS allows for the storage and retrieval of information; the update of information and the generation of reports (9:66,67; 14:502; 46:24). For the MIS, " ... the DBMS must be able to recover or restore a damaged data base from backup copies and logs or audit trails of data base activity" (46:24). Because information is such a valuable asset of an organization (10:7; 22:20, 25), precautions must be taken to prevent its loss or alteration. The DBMS serves as one type of precaution; others were presented in Chapter I.

Although authors cannot agree on a standard definition of MIS, most seem to agree that planning for a MIS is a must (4; 5; 6:17; 14:44-468; 23; 34; 40; 47:89-119; 56; 58; 61). Any kind of information system " ... is complex and therefore needs an overall plan to guide its initial development and subsequent change" (14:444).

This plan should cover the following areas:

1. the goals and objectives of the information system (14:447);

2. an inventory of the organization's current capabilities as far as information technology is concerned (14:47; 61:52);

3. a forecast of any developments (i.e., technological) that may affect the plan (14:447; 61:52); and

4. a specific plan that details schedules for the next three to five years (14:450; 61:52).

The master plan can be developed using one of several planning processes. Two of the more popular methods are briefly described, then the "Three-Stage Model of MIS Planning" is presented in more detail.

Critical Success Factors Methodology.

> Critical success factors are those few things that must go well to ensure success for a manager or an organization, and therefore, they represent those managerial or enterprise areas that must be given special and continual attention to bring about high performance. (6:17)

The critical success factor methodology attempts to define those tasks that must be performed to ensure success, and once those tasks are identified, performance measures are developed to evaluate the organization's level of success (6:17; 14:483,485; 34:192-193; 47:96-102). The actual critical success factors and the performance measures are derived from interviews between a skilled analyst and senior managers representing all areas of the organization (6:17; 34:193; 47:97).

After all of the managers have been interviewed, the conglomeration of critical success factors is condensed into organizational critical success factors (6:17-18; 34:192; 47:99). Once the organizational critical success factors are adopted, information resources and activities are aimed at the identification and prioritization of specific systems that will enable the organization to efficiently and effectively accomplish the key tasks (47:100,101).

This is where the planning stage ends and where the system development begins. Prototyping is considered to be the best technique for system development (6:25; 47:100,101) in the critical success factors methodology because benefits reaped from the system " ... can begin early and system performance can be assessed and refined along the way" (47:100). Since system development is beyond the scope of this section, information relating to this area is not presented.

The critical success factors methodology provides a structured procedure for a complete MIS planning effort. It begins with the identification of organizational and information systems goals and ends with the identification of specific information systems that will best benefit the organization.

Business Systems Planning (BSP). BSP was developed by IBM, and it is the most well known planning method (14:485; 40:447; 47:102). There are 13 steps in the BSP (14:484; 40:446-447; 47:103), but they will not be listed here. Instead, a brief synopsis of the methodology is presented.

Basically, the BSP starts with the identification of the organization's objectives and the business processes, "the activities that are key to the success of the business ... " (47:103). The key activities are examined to identify the information needs and from this examination, information that should be monitored throughout the organization is grouped into logical categories. The organization is analyzed to determine which, if any, departments or sections are currently supported by information systems, and top management is interviewed to determine their particular information needs. From all of the information collected, particularly top management's information needs, a final plan is developed that defines the costs, potential benefits, and a schedule for the development of an MIS. (14:484-485; 40:446-447; 47:103-104)

The BSP process is a very effective method for the development of a master plan. Not only that, but the entire

methodology is "well supported by materials and instruction" (14:485) by IBM.

Three-Stage Model of MIS Planning. This model, or methodology, includes strategic planning, organizational information requirements analysis, and resource allocation. According to Bowman and others (50) and Davis and Olson (14), these activities should be performed in the order they are presented.

Strategic Planning. As stated in Chapter I, strategic planning establishes a relationship between the MIS plan and the overall organizational plan. To establish this relationship, an assessment of environment, goals, objectives, and strategies of the organization must be made From this assessment, the objectives, goals, strategies, and mission of the MIS must be developed. (5:14; 14:456)

According to Bowman and others, the results of this activity

> ... should be an accurate perception of the strategic aspirations and directions of the organization, a new or revised MIS charter, an assessment of the state of the MIS function, and a statement of policies, objectives, and strategies for the MIS effort. (5:14)

Organizational Information Requirements Analysis. The goal of the second activity of the three-stage planning model is to develop a plan that specifies the MIS subsystems, their rankings, and their development schedule. This plan should be based on the identification and evaluation of the organization's current information needs and on the prediction of the organization's future information requirements. (5:14-16; 14:460-462)

Resource Allocation. The purpose of this third activity is to allocate resources in such a way that the plan developed in the information requirements analysis stage can be set in motion (5:16; 14:463).

Most organizations have limited resources for information systems and because of this limitation, not all MIS subsystems identified during the strategic planning phase can be developed and implemented simultaneously. To determine in what order the subsystems are to be developed and implemented, Davis and Olson suggest an evaluation of each subsystem (project) based on four factors (14:463). These four factors are:

> 1. The expected costs savings or profit improvement resulting from the project. This is an analysis of quantitative factors. (14:463)

2. Cost savings or increased profit which cannot easily be quantified. These are judgmental factors which are expected to have a favorable result, but are difficult to measure. Examples are improved customer satisfaction .... (14:463)

3. Institutional factors such as the need to have the development proceed in an orderly fashion or the need to have the entire organization involved in a new information system .... (14:463)

4. System management factors. Some systems need to be prepared before others. Certain software packages must be developed so that there can be suitable interfaces. Personnel may be in short supply which affects the scheduling of projects, particularly those requiring specialized expertise. (14:463,465)

At the end of this last stage, the organization should have a comprehensive master plan that will guide the organization in their MIS efforts.

There are several methodologies for MIS planning, and one has not been determined to be better than the rest. The methodology selected will depend on the organization and its preferences. No matter which methodology is chosen, it should include management and user participation to ensure the developed plan is based on the organizational plan and that it meets overall organizational MIS objectives (2:25; 14:467; 18:732; 39:287; 40:446-447; 61:52). Without any MIS planning, it is reasonable to expect that the resulting MIS will be a failure.

Although there isn't a standard definition for MIS, there appears to be an common focus, expressed in many different ways, that shows up in every definition. This focus is the goal of improving the performance of people, especially managers' performance, in organizations through the effective design, implementation, and use of computer-based systems (2; 4; 5; 14; 18; 23; 24; 34; 39; 40; 56; 61).

III. Methodology

The Historical Research Method

The historical (library) method which, according to Busha and Harter (8), Emory (25), and Powell (55) consists of five basic steps, was used in combination with unstructured interviews to solve the specific research problem. The following five steps of the historical method are necessary in the investigation of historical data:

1. Identification of the problem, or proposal of the purpose of the research.
2. Collection of background information.
3. Formulation of a hypothesis or research question.
4. Collection of evidence to support the hypothesis or answer the research question.
5. Formulation of inferences, conclusions, or further hypotheses. (8; 25; 55)

The Historical Research Method for this Study

1. Identification of the problem was accomplished with the formulation of the problem statement presented in Chapter I, Introduction.

2. Collection of background information began with articles published in Labor Law Journal, Employee Relations Law Journal, Personnel, Science, Government Executive, MIS Quarterly, Harvard Business Review, and Administrative Science Quarterly that deal with drug abuse, drug testing, and MIS or information resource management. The result of this research was the location of such articles as "The Right to be Tested" (29), "Employee Urine Testing and the Fourth Amendment" (3), "The Age of of Urinalysis" (44), "Promoting the Value of Information" (10), and "The Implementation of Strategic Information Systems Planning Methodologies" (40).

A search of the Cleveland State University Law Library using the LEXIS computer system was also conducted to locate legal arguments relating to employees' rights. This search produced several court cases such as "National Federation of Federal Employees v. Caspar Weinberger" (51) and "Utility Workers of America v. Southern California Edison" (63) which demonstrate the arguments justifying a relaxation of Fourth Amendment rights to allow drug testing in certain circumstances.

Further sources were located through the use of reference guides such as the Business Periodical Index,

Bulletin, American Doctoral Dissertations, and the Bibliographic Index: A Cumulative Bibliography of Bibliographies.

3. Formulation of a research question was accomplished with the formulation of the problem statement and the investigative questions presented in Chapter I along with the collection of background information.

4. Data collection was accomplished at various libraries that carry publications and further research materials cited in (2) above. Such libraries are located at the Air Force Institute of Technology; USAF Medical Center, Wright-Patterson Air Force Base; Wright-Patterson Air Force Base Legal Office; Wright State University; University of Dayton; and Ohio State University. Data collection also included information obtained from interviews with experts on the Air Force drug testing program. These experts included people such as Dragoslav T. Marcovich, PhD, Chief, Analytical Sciences, and Major John T. Cody, Assistant Director, both of the Air Force Drug Testing Laboratory (AFDTL) located at Brooks Air Force Base in San Antonio, Texas. This laboratory conducts all of the drug testing for all of the Air Force bases located in the continental United States, Alaska, and Panama (11).

5. Formulation of inferences, conclusions, or further hypotheses. Following the previous four steps, the data was examined and the evolving relationships were studied. The findings were then interpreted with respect to the specific problem. The conclusions reached during this step will be presented in Chapter V, Conclusions and Recommendations, along with recommendations for further studies.

IV. Findings

Introduction

This chapter presents the findings of the information collected through the literature review and the personal interviews conducted at Brooks AFB, TX. The findings related to the specific research problem are presented first, according to the order of the investigative questions. These findings are followed by additional findings of interest which are unrelated to the specific research problem.

Findings in Terms of the Investigative Questions

Investigative Question 1. What is the accuracy of the drug tests used in the Air Force Drug Testing Laboratory?

Governed by DODD 1010.1 (17) and AFR 30-2 (19), the AFDTL uses an RIA process and the GC/MS to detect positive urine specimens. Although DODD 1010.1 directs only two tests be performed on a possible positive urine sample (17:3-1), AFDTL actually performs three, two using the RIA process and one using the GC/MS.

All urine specimens arriving at the AFDTL are processed through an automatic, initial RIA test which is called "screening" by the AFDTL. Samples testing negative from this initial process are discarded and reported as negative while those producing a positive result are retained for further testing (42). Those positive samples, called presumptive positives (19:25; 28:83), are then reprocessed using a manual RIA process. This second test, referred to as "initial," is done manually because this supposedly allows for more control. However, the initial test actually is a weak process <u>because</u> it is done manually. The main reason that this is so is because of a process called "decanting" that is incorporated into this initial test. (42)

Decanting is based on timing, and it attempts to ensure each of the presumptive positive samples contained in test tubes are all treated in exactly the same manner (42). Decanting is not as easy as it may sound since it involves a laboratory technician to count aloud while pouring excess liquid from the test tubes and blotting the test tubes prior to the test tubes being centrifuged. Statistics do show that errors have occurred because of a technician

miscounting or not treating each test tube exactly the same way (42).

After viewing the decanting process at Brooks AFB, this researcher understands how it is possible for mistakes to be made. The test tubes subjected to this process are not handled individually; they are handled as a group contained in a rack that holds up to 12 test tubes. When pouring the excess liquid from these test tubes, the slightest twitch of the technician's hand could cause different levels of liquid to be poured from each test tube. It would also be very easy for the technician to miscount during the process since the slightest disturbance could interrupt his or her concentration.

Again, if specimens are determined to be negative following the initial test, they are reported as negative (42). Those specimens showing up as positive are again retained for further testing by GC/MS. This third test is called the "confirmation test" (42).

Prior to the specimen actually proceeding through the very slow and expensive GC/MS process, it must be subjected to the process of manual "extraction" (42). Extraction, in simple terms, is the removal of the drug compound(s) from the urine specimen. It is done manually, one specimen at a

time. Once the compounds have been removed and treated, a process that takes several hours, they are tested using GC/MS (42).

Although the occasion is rare when a specimen shows up positive in the first two tests and then produces a negative test result from the GC/MS, it has happened. When this occurs, the specimen is reported as negative because the GC/MS is a more sensitive process than the RIA (42). A specimen with a positive outcome from the confirmation test is finally reported as a positive test result (28:83; 42).

Other than the possibility of errors occurring during the two manual processes discussed above, the AFDTL uses very accurate methods of drug testing. The GC/MS, the final procedure in testing presumptive positives, is " ... the most sensitive and specific method of drug detection available" (19:25) and is " ... considered to be the most conclusive method of confirming the presence of a drug in urine" (28:81). In fact, it is generally considered to be 100 percent accurate (28:85; 42; 44:16).

Although alternate methods, such as the saliva test and brain scan test, have been claimed to be very accurate and to measure the level of intoxication, Doctor Marcovich and Major Cody disagree.

According to Doctor Marcovich, the saliva test is fairly reliable; however, it can be tricked. There are certain things that an intoxicated person can eat prior to the test to produce negative results. (42)

Both Doctor Marcovich (42) and Major Cody (11) said the manufacturer of the brain scan test "claims" it can measure the level of intoxication by reading a person's brain waves. In reality, there is nothing on the market that can accurately determine when a drug was taken or to what level a person is intoxicated (1:59; 3:615; 11; 28:83,84; 31:36; 37:238; 48:66) and, as far as Major Cody knows, there are no studies currently being done to develop a procedure that can (11). Therefore, the Air Force will not elect to use either of these tests for drug testing.

Investigative Question 2. How can an MIS enhance the current Air Force drug testing program?

From information gleaned from the literature and the personal interviews, this researcher noted three specific areas for potential enhancement by the application of MIS concepts. These three areas are presented in this section while suggestions for the application of MIS concepts are presented in Chapter V.

One area that could possibly benefit by the application of MIS concepts is the receiving area for specimen shipments. According to AFR 30-2 (19), AFR 160-23 (18), and Doctor Marcovich (42), once shipments are received at the AFDTL and inspected to ensure they have not been tampered with, each specimen bottle and its corresponding test tube are labeled with an accession number. This accession number is annotated on the AF Form 1890, Urinalysis Custody and Record Report, next to the donor's name and social security number. (For the remainder of this section, the AF Form 1890 will be referred to as the manifest.)

Every time a test tube changes hands in the AFDTL, the test tube and the manifest have to be visually cross-referenced to assure the proper specimen is being transferred (17:5-1; 42).

This may sound like a simple procedure, but, in reality, it is difficult and time consuming. When a test tube is moved from the reception area to the RIA laboratory, it is rarely transferred alone. According to Doctor Marcovich (42), several racks containing up to 12 test tubes each are transferred at once. The person receiving the racks must visually cross-reference the manifest with the

test tubes to ensure the test tubes are positioned properly in their racks in accordance with the manifest.

Another area lending itself to enhancement by an MIS is the Forensic Documentation Branch in the AFDTL. According to Ms. Williams (66), Results Reporting, a division of the Forensic Documentation Branch, has a night shift that manually inputs information, such as the base identification numbers, social security numbers, laboratory accession numbers, and the date specimens arrive at the AFDTL, from the manifest that accompanies the specimens onto a floppy disk. This floppy disk is then hand carried to personnel in Documentation Control who update the AFDTL database.

When all of the tests have been completed on specimens listed on a particular manifest, Results Reporting updates the corresponding floppy disk with the completion dates of the tests. This floppy disk is again taken to Documentation Control, and Documentation Control updates the database. (66)

This practice doesn't appear to be efficient since Results Reporting has access to the database and could feasibly update the information. The current practice seems to cause unnecessary delays in information processing because

of the dual updates and the time wasted transporting the floppy disk between sections.

The AFDTL is required to maintain certain documents concerning the drug tests for a minimum of two years. These documents include the completed laboratory report forms; chain of custody documents; and records of the screening, initial, confirmation, and retests for positive specimens. (18:3-2; 66)

Results Reporting physically maintains files containing laboratory results. Any question concerning a particular specimen, provided the inquirer has the originating base's identification number, the social security number of the donor, or the results report number and/or date, can be answered by Results Reporting (66). However, Results Reporting personnel must physically go to one of the many file cabinets maintained in the section and locate the particular manifest or report. These people cannot access the database to locate this information since the database only contains information on specimens currently in the laboratory, specimens undergoing testing and specimens that have arrived in the laboratory but have not yet begun the testing sequence (66). In other words, the AFDTL database contains only the information provided on floppy disks by

Results Reporting and transferred to Documentation Control. This is a serious problem resulting in much wasted time.

Investigative Question 3. How can the information derived from the drug testing program be more tightly secured or protected from unauthorized access?

The AFDTL appears to be a very security conscious organization. The AFDTL is a restricted area, and the 93 employees must wear restricted area badges while in the building (11; 32; 42). When employees enter or leave the building, they must sign in or out, and when they leave the building, they leave their restricted area badges at the control desk at the front of the building (42; 66).

Non-employees can gain access to the building only by checking in at the control desk and receiving a visitor's badge that must be worn at all times. Once permitted into the building, a non-employee must have an escort, an employee with escort privileges annotated on his or her restricted area badge. (32; 42) This prevents non-employees from entering unauthorized areas alone, such as Results Reporting where all laboratory results are maintained.

As far as computer security is concerned, the AFDTL currently uses a password system (32). This system allows only authorized employees access to the database, although there is currently very little sensitive information maintained in the database.

Captain Gentry (32) indicated that when and if the need arises in the future, the need being that increased amounts of sensitive information are maintained in the database and require additional security, increased computer security procedures will be implemented. Captain Gentry specifically mentioned two possibilities.

One possibility involved the continued use of passwords. Authorized users would still have a password to access the database, but the system would be programmed to completely lock up if three illegal attempts were made. If the system locked up, no one could access the database until an individual from Technical Services arrived at the laboratory, inspected the system to ensure access was not being attempted by an unauthorized person, and reprogrammed the system to allow authorized access. (32)

The second possibility also involved the use of passwords, but it included the additional requirement of voice recognition. Captain Gentry (32) alluded to the fact that

the AFDTL has the equipment available to make voice recognition an integral part of their present system, but what he proposed was that passwords and voice recognition be used in conjunction with one another.

The system would have voice prints of all authorized users and would associate each user's password with his or her voice print. The system would grant access to a user if, when the user said his or her name and password aloud while typing the password, the typed and spoken password matched the user's voice print committed to the system's memory. (32)

Additional Findings

While conducting research at the AFDTL, additional information, unrelated to the specific research problem or the investigative questions, was obtained. In some cases, additional research was accomplished to verify this information, and the findings are presented here.

Finding 1. Two of the articles researched indicated that some over-the-counter medications (28:84; 44:16), such as diet pills, Advil, Dristan, and Midol (3:614; 28:84) can produce false-positive results by causing amphetamines and/or THC to be detected in the initial urine sample.

Poppy seeds used in bagels, cakes, and some salad dressings can also cause opium or morphine to appear in drug tests (28:83; 29:75; 44:16) because poppy seeds " ... naturally contain some traces of opium or morphine, ... " (28:83). Two articles also suggested that, since research has shown that passive inhalation of tobacco smoke is hazardous to the health of nonsmokers, passive inhalation of marijuana can cause THC to be detected in urine samples of nonsmokers (3:616; 31:35).

According to Fay (28) and Marcovich (42), the problems with the over-the-counter drugs have been eliminated by the the GC/MS (confirmation test). The GC/MS has such a high level of sensitivity that it can distinguish between the chemical make-up of the over-the-counter drugs and the ion patterns characteristic of the specific drug being tested for (28:81; 42).

Both Fay (28) and Marcovich (42) concede that poppy seeds can produce positive results in both the screening, initial, and confirmatory tests. In his article, "Let's Be Honest About Drug Testing", Fay states " ... the test cannot differentiate between oral ingestion of poppy seeds or intravenous injection of morphine" (28:83).

According to Doctor Marcovich (42), the DOD and the AFDTL have compensated for the tests' inability to differentiate between the oral ingestion of poppy seeds and the intravenous injection of morphine by raising the minimum level of drug concentration that must be present in the urine specimen to be considered positive. For a urine specimen to produce a positive result with this higher level of concentration, a person must consume five pounds of poppy seeds within a short period of time prior to the test (42).

Although passive inhalation has been claimed by marijuana smokers as the reason for a positive urine specimen, passive inhalation cannot produce a THC count strong enough to be detected by the immunoassay tests or the GC/MS (42). Doctor Marcovich's statement is supported by a study done to examine the effects of passive inhalation of two to four marijuana cigarettes for three days in a medium size car and in an 8 foot by 10 foot room (28:85). The conclusion of this study is as follows:

> ... some rather severe conditions are necessary to produce positive test results from passive inhalation. It is extremely improbable that a person would unknowingly tolerate the type of noxious smoke environment for the length of time necessary to absorb the threshold dose of THC needed to exceed the cutoff level. (28:85)

Finding 2. All urine specimens sent to the AFDTL are tested for THC (marijuana) and cocaine. Ten percent of all specimens are tested for the "Drug of the Month" (42). The "Drug of the Month" is randomly predetermined by AFDTL personnel prior to the beginning of each month, and they are the only people privy to this information (42).

Finding 3. Military personnel working in the AFDTL are subjected to urinalysis testing at least once every quarter; however, the AFDTL does not perform these tests (32). Urine specimens collected from AFDTL military personnel are sent to and tested by one of the Army drug testing laboratories located in Fort Meade, Maryland (32). The Army also conducts drug testing for the Air Force's bases located in Europe and the Pacific. The Army Drug Testing Laboratory located at Tripler Army Hospital in Honolulu, Hawaii services Pacific Air Force bases while the Army Drug Testing Laboratory at Weisbaden Air Base, West Germany services European Air Force bases. (11)

Finding 4. The AFDTL spends approximately $1,250,000 a year for the antibodies and antigens required to perform the RIA tests (42). With a year's worth of supplies, the AFDTL can test approximately 900,000 urine specimens (42). By performing simple division, it can be determined that it

costs the AFDTL approximately $1.50 to run a specimen through screening or an initial test.

Summary

This chapter presented the findings of employing the methodology specified in Chapter III. The findings included information collected from a review of the literature and from personal interviews conducted at the AFDTL.

V. Conclusions and Recommendations

Introduction

This chapter provides a summary of the conclusions that can be drawn from the findings furnished in Chapter IV. Additionally, suggestions and recommendations for further study relating to the enhancement of the drug testing program via the application of MIS concepts are presented.

Conclusions

The original problem statement sought to determine if MIS concepts could be used to enhance the Air Force drug testing program. To aid in this determination, three investigative questions were formulated. Although only one of these questions dealt directly with both the drug testing program and MIS, it was hoped that information obtained from the other questions would shed light on different aspects of the drug testing program where MIS concepts may be applied. The investigative questions served as the foundation upon which the literature review and informal interviews were built. It was anticipated that by analyzing the information obtained from the literature review and the interviews, each

of the investigative questions would be answered, and ultimately, the original problem, as stated in the problem statement, would be satisfied to the highest degree possible.

The following conclusions and suggestions for enhancement of the drug testing program are presented as related to the original investigative questions to which they pertain.

Investigative Question 1. What is the accuracy of the drug tests used in the Air Force Drug Testing Laboratory?

From all indications, the actual tests (the RIA and the GC/MS) performed on urine specimens at the AFDTL are the best technology has to offer today. However, it has been noted that human errors can and have been made during manual manipulations of each test, decanting in the RIA and extraction in the GC/MS.

From advanced research and development projects, technologies have been developed that can make the manual decanting and extraction procedures obsolete. One such technology is "robotics." A robot is

> a programmable, multifunctional manipulator designed to move material, parts, tools, or other specialized devices through variable programmed motions for the performance of tasks. (12:26)

Since both decanting and extraction are tedious and time consuming jobs that require precision, the robotics technology appears to be an avenue that should be pursued for use in the AFDTL. There are several reasons for this mode of thinking.

The first, and probably most important, reason to believe robotics is a feasible technology for the AFDTL is the "one-armed chemist" (30:117), the Zymark robot. This system was developed specifically for sample preparation in the chemistry laboratory (30:116,117). Since robots are programmable (12:26; 30:117), it is conceivable that this system could be reprogrammed to perform the specific functions required for decanting and extraction.

Since the Air Force is one of the largest monetary supporters of robotics research and development (60:58), specific research efforts could be focused towards the development of a robotics system for the AFDTL. The Air Force Materials Laboratory has worked on robotics projects in the past (60:60), so it's possible this laboratory could be enlisted to develop a unique system for decanting in the RIA laboratory and for the extraction process required for the GC/MS.

There are a few advantages of robotics that make this technology even more viable for consideration. Some of these advantages are listed next.

1. Robots can be programmed to detect minute deviations from standards and to perform a sequence of tasks repetitiously and consistently. Because of this capability, a specific pattern can be reproduced for lengthy periods of time with great accuracy. (12:28; 30:117)

2. Robots do not get distracted; therefore, they tend to produce more accurate results than do humans performing the same tasks (12:28; 0:117).

3. Robots can be operated for less than what it would cost to pay an employee to perform the same operation (12:28).

4. What may be a time-consuming operation for a human may take only half as long when achieved by a robot (12:28; 30:117).

5. Robots do not sabotage organizational operations or disclose sensitive information (12:28).

All in all, robots have considerable advantages, and their installation in the AFDTL could solve the problem of possible human errors.

Investigative Question 2. How can an MIS enhance the current Air Force drug testing program?

In Chapter IV, three areas in the AFDTL were addressed individually for potential enhancement by the application of MIS concepts. This section will present conclusions and suggestions for improvement for each of the three areas in the same order as they were presented in Chapter IV.

The first area identified was the receiving area for specimen shipments and the transference of specimens between areas in the laboratory. From the findings, it can be concluded that the inspection and the visual cross-referencing of test tubes and manifests are both processes that require great attention to detail by laboratory personnel. Because these processes require such precision in the identification of specimens, they tend to be very time consuming.

There is a system available today that could be applied to these processes to reduce the time required to identify each specimen and to cross-reference each specimen with the associated manifest. Not only will the time be reduced, but the accuracy of specimen identification and control will be maintained and, more likely, improved. The system referred to is a bar code tracking system.

> Bar-coding is a technique for storing important information in a compact form that can then be used to identify the item and facilitate its management. (65:106)

A bar code " ... represents a set of alphanumeric characters by means of thick and thin lines interspersed with wide and narrow spaces" (65:108), and a bar code can be read easily with an electronic optical system, usually a pen-shaped light wand, called a scanner or bar code reader (47:61; 53:81; 65:106,108). According to Weldon , a scanner can read bar codes more accurately than it can read human text, " ... only one error for every three million characters" (65:108).

To implement a bar code tracking system in the AFDTL, certain equipment must be present. The system requires a central computer, a dot-matrix printer, and scanners with small displays that transmit data to the computer (53:81). Although the initial monetary outlay for the system components may cause hesitation in implementing such a system, the benefits of utilizing a bar code tracking system must be realized to justify the expenditures. Such benefits include reduced cycle times (53:80), which means the time needed to process a urine sample through the drug testing sequence can be reduced; rigidly controlled location of the specimens

(53:81), meaning the chain-of-custody can be tracked through the bar code tracking system; and error-free identification of specimens since scanners can read bar codes with better than 99 percent accuracy (53:81; 65:108).

To better understand how a bar code tracking system can be used in the AFDTL, a scenario of the drug testing laboratory equipped with the system is presented.

When a shipment of urine samples arrives at the AFDTL receiving area, a technician inspects the shipment as directed by AFR 30-2 and AFR 160-23. Once the technician has determined that the specimens correlate to the manifest, a technician or computer operator will type the information from the manifest into the central computer. The computer will assign an accession number to each entry and then convert each accession number into a unique bar code (53:81). The computer will send the bar code symbols to the dot-matrix printer, and the printer will produce at least three copies of the bar code for each accession number (53:81). The three bar code labels associated with a particular accession number will be affixed to the bottle containing the original urine specimen, a test tube, and to the manifest next to the name for which the bar code (accession number) pertains.

Once this has been accomplished, a test should be executed to ensure the bar code labels are read accurately. A scanner is waved across a bar code label on the manifest and then across the original specimen bottle and the test tube associated with that manifest entry. The data from the bar codes are transmitted to the central computer and if all three bar codes match, the process can continue with the scanning of each manifest bar code label and its associated specimen and test tube labels. If the bar codes do not match, the computer will so indicate with either a short message to the scanner display, a noise message such as a beep, or both.

This scanning process will be accomplished every time test tubes move from one area of the AFDTL to another. The person receiving the samples will scan the bar code on his or her restricted area badge to notify the computer who is taking possession of the test tubes, and then the person will proceed by scanning the manifest and test tubes to ensure the proper specimens are being transferred. When the process is complete and no errors have been detected, the person receiving the test tubes will initial the manifest to indicate the correctness of the transference procedure.

This bar code tracking system could save the AFDTL time in accurate specimen identification by deleting the possibility of errors caused by a person misreading information when visually cross-referencing the manifest and the test tube identification labels. This system can also save time in detecting who has handled the specimens, where the specimens are, and where they have been since all of this information has been stored in the computer with each wave of the scanner. All that is required to obtain the information is a simple inquiry to the central computer. Overall, this system could be an asset to the AFDTL.

The Forensic Documentation Branch, particularly the Results Reporting Section, is currently performing unnecessary tasks that waste time and cause information processing delays. These tasks were identified in Chapter IV as the input of information from manifests, the updating of information on floppy disks, and the maintenance of laboratory documents.

A logical, possible solution to the input of information by the Results Reporting night shift involves the use of electronic data interchange (EDI) (45; 47:74) or the Defense Data Network (DDN) (15; 24; 47:175).

EDI is the computer-to-computer exchange of documents prepared in accordance with previously agreed-upon standard formats by the sending and receiving parties of the documents (45; 47:74). The standard formats define " ... the format and sequence of data for a specific type of transaction" (47:77), thus allowing both parties the capability to determine what information belongs where in a certain document.

The AFDTL could use this technique to receive the information required on an AF Form 1890. The base conducting drug testing could key the information from the manifest into their computer and transmit it to the computer at the AFDTL. The only thing that would be required of the AFDTL is the assignment of accession numbers when the actual shipment arrives and the printing of the hard copy of the manifest. This technique could prevent the redundancy of tasks by the originating base and the AFDTL since the night shift in Results Reporting would no longer be required for manifest information input.

> The Defense Data Network (DDN) is a large military common-user data communications internetwork operated for the Department of Defense (DOD) by the Defense Data Network Program Management Office (DDN PMO) of the Defense Communications Agency (DCA). (15:8)

The DDN is actually an umbrella of network segments, and each segment is a network that operates independently of all other segments. The major segments of the DDN are ARPANET, a military research and development network; MILNET, a system serving the DOD's operational users; WINCS, a network that meets the Joint Chiefs' of Staff Command Control Communications Intelligence needs; and DISNET and SCINET, networks created for the purpose of exchanging classified information (15:9,18; 24:1[illegible]-122). The DDN is available for use by government personnel, such as military departments, DOD agencies, and DOD contractors, for the purpose of conducting business on behalf of the United States Government (15:11; 24:122).

The AFDTL and all Air Force bases serviced by the AFDTL could employ either the ARPANET or the MILNET for the same purpose as was suggested for EDI. The DDN has three services that the AFDTL could feasibly select as the standard means for receiving manifest information.

The most common service provided by DDN is electronic mail (15:25; 24:122). Electronic mail allows users to " ... send messages electronically to one another" (15:25). With this service, the originating base could transmit a message containing the manifest information, formatted in such a way

as to resemble the actual manifest, to the receiving area of the AFDTL.

The AFDTL could choose to use DDN's TELNET program, a protocol that allows users to open a connection to a distant computer from their local computer (15:34), to receive manifest information. Using TELNET, the originating base would make a connection with the AFDTL's computer, log in using a user name assigned by the AFDTL and the base identification number, and input the data from the manifest directly into AFDTL's computer under a previously decided file name.

The third and final service the AFDTL could employ is the file transfer protocol. Basically, this protocol sets up a communications path between a sender and a receiver and allows for the transmission of data between the two (15:31; 46:265-268,314). As with electronic mail, the originating base could simply format a file to resemble the manifest, key in the information, and transmit the entire file to the AFDTL.

No matter which of the two options, EDI or DDN, the AFDTL chose to employ, the results would be the same. AFDTL personnel would not waste time reproducing manifest information or updating a floppy disk. Since the information would be present in the AFDTL's information system, Documentation

Control or Results Reporting could simply transfer the information to the database and save it after the assignment of accession numbers. When all of the tests have been completed, either Documentation Control or Results Reporting would access the database and update the information with the test results and the test completion dates.

Although the AFDTL is required to physically maintain certain documents for two years or more, there is no reason the information from these documents cannot be maintained in the database. By maintaining this information in the database, AFDTL personnel have information at their fingertips that, otherwise, would have to be searched for in various file cabinets as is done now. At the end of every calendar year, the database could be purged of information older than two years.

According to McFadden and Hoffer, the " ... addition of more data of the kind already contained in the data base" (46:348) indicates a change in the size of the database. To accommodate for this growth, there are two measures that may be taken. One measure entails allocating additional space in the database storage unit and the other, reallocation of existing space, requires the unloading and reloading of the entire database (46:349). Technical Services could easily

allocate additional space in the database for the storage of two years' worth of information, and, in the long run, save the additional time and effort required in physically locating laboratory documents.

The evidence has been provided to indicate that the application of MIS technology has the potential of improving the current Air Force drug testing program so that information can be managed more efficiently and effectively.

Investigative Question 3. How can the information derived from the drug testing program be more tightly secured or protected from unauthorized access?

From the findings of the research, there is nothing to indicate that the information derived from the drug testing program, as it is currently documented, requires tighter security measures. The present physical security of documented information leaves nothing to be desired. The information is secured in locked containers (file cabinets) located in offices with cage doors equipped with cipher locks in a building designated as a restricted area. It would be very difficult for an unauthorized person to gain entrance into the building, let alone the file cabinets.

Since the content of the information currently maintained in the database is not of a sensitive nature (66), the password system currently in use for database access is adequate for the level of protection needed. However, if the AFDTL were to enlarge their database and maintain two years' worth of information from laboratory documents, especially test results, additional security measures will have to be implemented.

The two suggestions made by Captain Gentry, the system locking up after three unsuccessful access attempts and the integration of passwords with voice recognition (32), noted in Chapter IV are both practicable possibilities. However, they are not the only methods to be considered since there are other methods to secure computer information and prevent unauthorized access. Two of these alternate methods are presented next.

The implementation of authorization rules is one method that should be considered. Authorization rules are

> controls incorporated in the data management system that restrict access to data and also restrict the actions that people may take when data are accessed. (46:397)

Basically, these controls allow users to access only those files necessary for the performance of their jobs while

restricting the users from certain access privileges which do not fall under the realm of their position (46:398-399; 59:312). What this means is that, for a certain file, some system users may only be allowed access to read the file; some users can make changes to the file; other users may be authorized to erase or copy the file; and some users may not even know that a certain type of file exists (15:31; 46:398-399; 59:312). Instituting authorization rules can help prevent the illegal alteration of data, the intentional destruction of data, and the unauthorized access for the purpose of reading sensitive information concerning certain individuals.

The second method, used in conjunction with the password system, involves restricting certain computer actions to certain locations. For instance, receiving area personnel in the AFDTL assign accession numbers to specimens, so annotating the manifests with the accession numbers could only be done from a computer terminal located in the receiving area. Recording test results could only be accomplished from terminals located in the Results Reporting Section and, since some AFDTL personnel (e.g., the commander's secretary) have no reason to access any of the information obtained from the drug tests, access to

laboratory reports would not be authorized from terminals located in these individuals' work locations.

As stated before, the current security measures at the AFDTL are adequate for the level of protection required. However, if the AFDTL generates a need for increased information security, additional security measures should be incorporated.

Comprehensive Suggestion. Up to this point, the areas identified in Chapter IV as areas for enhancement have been treated individually. In this section, a suggestion that combines all of the previous suggestions for enhancement of the drug testing program by the application of MIS concepts is presented.

Since there is a system available today that permits the storage and retrieval of data in addition to tracking the status and physical location of samples as they proceed through a laboratory testing sequence (57:39), the AFDTL should consider the system for implementation.

The system referred to is a computerized laboratory information management system (LIMS) with a bar code interface (BCI) (57:39). This system provides system users with the ability to perform the following functions:

1. log samples into the database, which is similar to keying in manifest information;

2. receive samples for testing, which is almost identical to the assignment of accession numbers;

3. print reports;

4. identify the composition of a sample;

5. locate a sample; and

6. record physical location changes of a sample, which is basically chain-of-custody. (57:39)

To perform any one of these functions, a user simply scans a bar code on the system's main menu with a bar code reader. The *main menu*, bar codes printed on a sturdy card, contains several commands that represent the main functions of the system, and each command leads to another menu (57:39). The main menu of bar code commands recognized by this system is pictured in Figure 7.

Although this system is not a complete replacement for laboratory terminals and keyboards, it offers several advantages that cannot be overlooked.

The actual bar code equipment is very compact, one sixth of the size of an average terminal, and requires less space than terminals and keyboards do (57:39-40). Since the

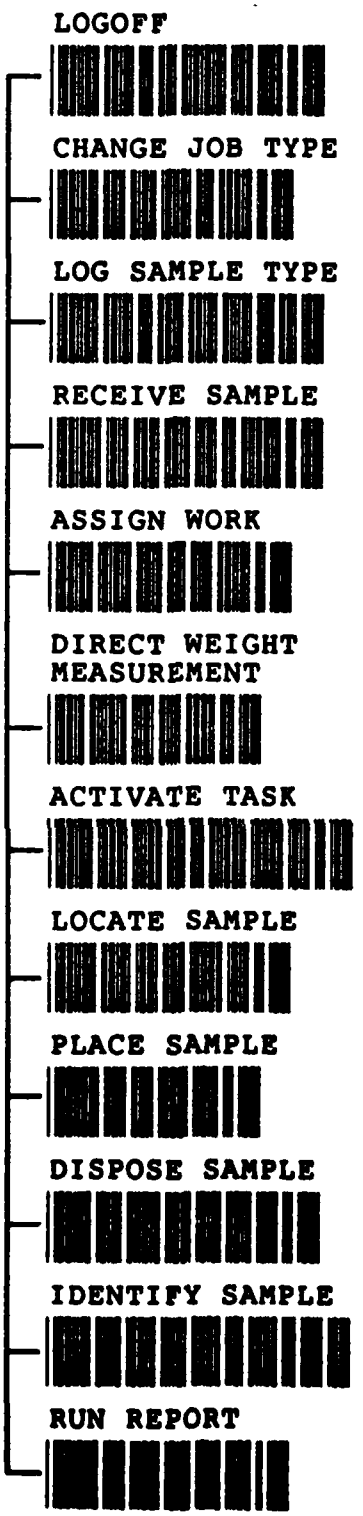


Figure 7. Main Menu of the LIMS With BCI Interface (57:40)

bar code reader does the work of a terminal, it can be substituted for most of the laboratory terminals (57:39-40).

The bar code equipment, particularly the bar code reader, is easy to use and requires very little training. Not only that, but scanning bar codes instead of typing at a keyboard while viewing a terminal screen allows a user to perform many functions more quickly and accurately than they are accomplished now. (57:39,43)

This system addresses the security issue by controlling access to data through the combination of several security measures: user identification, passwords, job types, and data groups. To access the system, a user must scan bar codes that represent his or her user identification and password. The system must recognize the bar codes as valid information for logging onto the system or it will deny access to the user. This is the system's first level of security, and it controls access to the entire system. (57:43)

The next level of security is actuated by job types. Each user of the system is assigned a job type that enables him or her to perform various system functions. If a user attempted to perform a function not listed in his or her job type, the system would not respond. For example, if a

user's job type allowed him or her to log and receive samples, the system would not respond to the user scanning the bar code for activating a task. (57:43)

The third level of security, which controls access to records stored in the database, is provided by data groups. "A data group is an entry in every laboratory data record, such as those containing samples, tasks, and results" (57:43). Users also have records that contain data groups, and if a user's data group isn't identical to the data group in a laboratory record, the user can't access the data in that laboratory record (57:43). This security measure is similar to authorization rules described in the previous section.

Overall, the technology of the LIMS equipped with the BCI provides a means for performing many laboratory functions more easily, more quickly, and more accurately than the terminals and keyboards (57:43) currently in use at the AFDTL.

Recommendations for Further Study

Recommendation Number One. Further research aimed at the integration of robotics into the RIA and GC/MS laboratories to perform the decanting and extraction processes

should be conducted by the Air Force Materials Laboratory and the AFDTL. If robotics are deemed feasible, research efforts could be geared specifically to the development of a robotics systems for the AFDTL or towards the modification of the Zymark robot to meet the AFDTL's needs.

Recommendation Number 2. A bar code tracking system, or a prototype, could be introduced to the AFDTL on a trial basis. A study could be accomplished by the AFDTL Technical Services Section to ascertain the actual benefits the system can provide.

Recommendation Number 3. Further research should be conducted by Technical Services with the goal of developing a standard format for the transmission of required documents between Air Force bases and the AFDTL by way of the DDN.

Recommendation Number 4. The effect of increasing the amount of information stored in the database should be studied and, if necessary, a new database should be designed.

Recommendation Number 5. The LIMS equipped with the BCI should be extensively studied to determine if it can be advantageously used in the AFDTL. If the system is determined to be inadequate for the AFDTL's needs, perhaps

continued modification testing to the LIMS and the BCI could yield the perfect system for the AFDTL.

Summary

This chapter detailed the conclusions drawn from the analysis of the research information. Additionally, several suggestions for the enhancement of the Air Force drug testing program by the application of MIS technologies were presented. Recommendations for further study in various areas concluded the chapter.

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This study examined the possibility that MIS can be applied towards the current Air Force drug testing program and result in an improved program. Current literature, including AF regulations and DOD directives, and information obtained from informal interviews conducted at the AFDTL were reviewed and analyzed. The findings indicated that there are areas in the drug testing program and the AFDTL itself that can be enhanced by the application of MIS concepts.

These areas include the manual processes performed throughout the drug testing sequence; information processing under the control of the Forensic Documentation Branch; the information maintained in the AFDTL database; and the transfer and maintenance of information relating to the drug testing program for AF bases serviced by the AFDTL.

Suggestions from this author regarding the application of MIS to these specific areas were presented in Chapter V. Current literature was also cited in Chapter V to substantiate these suggestions.

Since it was beyond the scope of this study to determine if the suggestions can be feasibly incorporated into the drug testing program, recommendations for further study were presented. Future study (or studies) should be geared specifically to the integration of robotics, bar coding, and additional automation into the drug testing program.